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Biography

THE TWO PRESIDENTS.

WITH a view to the encouragement of a closer spirit of comradeship between the great parent Associations of the two largest English-speaking countries of the world, we are publishing in this month's VETERINARY JOURNAL, as a frontispiece, the portraits (side by side) of the respective Presidents of the National Veterinary Association of Great Britain and Ireland and the Veterinary Medical Association of America.

It would be a nice idea to arrange an official interchange of delegates each year from either side of the Atlantic, and we commend the suggestion for the consideration of the Council of either body.

Those of us who have attended one of these Congresses in America can bear good testimony to the warm welcome which has been given, and we think, too, that we Britishers have not been behind-hand in the welcome given on this side to any stray American colleague who has so timed his wanderings in Europe that he has reached Great Britain just when the National was holding its session ; but an effort ought to be made to make the interchange of courtesies " official." The expense of travel is naturally a consideration, but in most years there is someone crossing over who could do the honours and convey the compliments, and once at the Congress his expenses would certainly terminate in the official welcome. The good done by these Congresses is so far-reaching in its effects that one never knows where the eddies end, and both at the National and at its prototype in America the hands of the clock are set for the work and social good feeling of the coming year. The duty of an official is an honour not to be lightly undertaken, for the Presidents and Secretaries can testify that neither is a *sinecure*.

In Professor Arthur Gofton we have had a man of energy who has brought his ship to a safe anchorage at the close of his Presidential year; and the same tact and quiet firmness which has made his opinion on Public Health matters so much respected by his colleagues in the City of Edinburgh has equally given him the respect and confidence of his colleagues on the Council of the National. The lead which the profession has taken in Scotland in Veterinary Public Health

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matters owes itself in no small measure to Mr. Gofton's advice and initiative, and we are grateful to him for it. Once a practitioner, then a teacher, and now a leader in Public Health matters, he is a man of whom the profession has good cause to be proud, and it is to be hoped that he will long be spared to enjoy and see the fruits of his labour.

Professor Louis Merillat, born in 1868, and a graduate of the Ontario Veterinary School just twenty years later, is best known to us on this side of the Atlantic by his authorship and writings and for the part he played in the building up of the McKillip Veterinary College in Chicago. He was one of those who insisted upon the course of study at this College (which was one of the privately owned ones) being made into one of three years; and in 1892 Dr. Merillat was its first Secretary. Surgery is his speciality, and his activities in this sphere have made him one of the most travelled and best known consultants and successful operators in the veterinary profession.

In 1916 Dr. Merillat was elected Secretary of the American Veterinary Association, and in 1917—joining up to "do his bit"—he was given a Major's commission and sent across to France. There he was promoted to the rank of Lieutenant-Colonel and was awarded the Legion of Honour.

As our contemporary, the *North American Veterinarian*, to whom we are indebted for the illustration, most truly says when speaking of the Presidentship, "his election is an honour earned."

Editorials

THE UNIVERSITY OF LIVERPOOL.

THE "WILLIAM PRESCOTT" CHAIR OF THE CARE OF ANIMALS—CAUSATION AND PREVENTION OF DISEASE.

WE draw the attention of our readers to an advertisement in our columns for applications to fill the above Chair, and which we hope will prove another landmark in the history of veterinary research. The duties of the Professor will include research and instruction in the subjects of the Chair, and the appointment will date from January 1, 1926, the stipend being fixed at £1,000 per annum. Intending applicants should send in their names to the Registrar, with the necessary testimonials, not later than September 15, 1925, and we hope that those who are qualified to apply will do so without delay.

We have now in our profession a large number of men who hold

either the double University degrees of human and veterinary medicine, or those of science combined with the M.R.C.V.S. It is obvious that the possession of a veterinary qualification is an absolute essential for the proper knowledge (*vide* the terms of the advertisement) of the "William Prescott Chair of the Care of Animals—Causation and Prevention of Disease," as no one is so well qualified as the veterinarian for duties which include research and instruction in the diseases of animals.

That veterinary research, when properly financed, can make good headway has already been proved both in this country and in our Colonies, and no man is better devoted by his training for the study of comparative pathology than the one who has received a complete modern veterinary training. In order to study animals in disease it is obvious that one should have a knowledge of them in health, and the best trained man in this respect is the modern veterinarian.

It is for us as a profession to look to our laurels, and, provided we prove by the scientific status of our candidates that we can produce applicants worthy of the Chair, we must strain every nerve to get it. We have cried out in the past about our want of opportunity in this direction. Here is an opportunity. Let us see that it is not lost by our own apathy or selfishness.

OPENING OF THE NEW RESEARCH INSTITUTE AT CAMDEN TOWN.

It must be a great source of gratification to our esteemed leader, Sir John McFadyean, to have lived to see the fulfilment of one of the dearest wishes of his life in the completion of the new Institute of Veterinary Research at Camden Town, which was formally opened by His Royal Highness the Duke of Connaught on Tuesday last, July 14th.

His Royal Highness was supported by a number of distinguished scientists (medical and veterinary), and also a number of prominent agriculturists and members of the Government. Those present included the Earl of Northbrook, the Right Hon. E. F. L. Wood, M.P. (Minister of Agriculture), Mr. Crookshank, Sir Stewart Stockman, Sir D'Arcy Power, Sir William Simpson, Sir Merrik Burrell, the President of the Royal College of Veterinary Surgeons, the Mayor of St. Pancras, and a large number of members of the Royal College of Veterinary Surgeons.

The Minister of Agriculture (the Right Hon. E. F. L. Wood, M.P.) emphasised, as did his predecessor (the Right Hon. Noel Buxton, M.P.) on the occasion when the foundation stone was laid, the importance of animal research, and promised that this good object should be

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supported, financially and in other ways, by the Government as far as possible.

After the ceremony the new buildings were inspected, and great satisfaction was expressed at the style of the laboratories and the satisfactory completion of the work.

AT LAST! COMING TO GRIPS WITH TUBERCULOSIS.

At last we are within measurable distance of a serious attempt to get rid of the tuberculous cow, and, as the official bulletin issued by the Ministry of Agriculture puts it, it has been under consideration "for some time past."

September 1st next will see the new Order in force, this being the date upon which the Milk and Dairies Consolidation Act 1915 (England and Wales) and the Milk and Dairies Act 1914 (in Scotland) will take effect.

Both these Acts forbid the use, for the production of milk, of any cow which is giving tuberculous milk or is suffering from tuberculosis of the udder or tuberculous emaciation. The Order will compel the slaughter of all such cows, and any other bovine animal, suffering from chronic cough with definite clinical signs of the disease or from tuberculous emaciation.

The onus of reporting such a case is put equally upon the veterinary practitioner as upon the owner, and compensation up to three-quarter value is paid upon the carcases in non-advanced tuberculosis or one-quarter only if advanced.

Tuberculous animals cannot be landed from Ireland, Canada, or elsewhere where tuberculosis exists.

The Order will make much more work for the veterinary inspectors, and, indeed, for the profession generally. It is estimated that the total gross compensation to be paid will average about £67,000 a year, of which the Exchequer will find about £50,000, and that the numbers of cattle slaughtered will average about 1,000 a month.

The effect on cattle generally, and on the milk supply in particular, cannot but be beneficial. It is welcomed universally as being a step in the right direction towards the eradication of the "great white plague" from both animals and man.

General Articles

THE ELUCIDATION OF CANCER.*

By LOUIS WESTENRA SAMBON, M.D., F.Z.S.,
Lecturer in London School of Tropical Medicine.

THE region rapidly surveyed by me is called Romagna. It is a territorial division of Italy lying south of the River Po, between the Reno and Cæsar's Rubicon, the foot-hills of the Apennines and the Adriatic Sea.

CANCER IN ANIMALS.†

I came across several instances of animals suffering from cancerous disease in close association with human cancer cases. Sometimes the malignant growth in the animal had preceded, at others it had followed, the disease in man. The cancerous animals thus associated were dog, cat, and barn-fowl. These, as is well known, suffer from true cancer, indistinguishable from that of man in both histological characteristics and biological features. I am inclined to attach considerable importance to the prevalence of cancer in domesticated animals which live in close touch with man.

HOUSE VERMIN.

A cursory inspection of farmhouses and other dwellings in which cases of cancer had occurred invariably revealed infestation by the common cockroach (*Blatta orientalis*). These insects, as a rule,

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† I made inquiry into any possible association noticed between cancer in man and cancerous diseases in the domestic animals, but found that no special attention had been given to the subject either by physicians or veterinarians. However, several cases were mentioned which had obtruded themselves on public observation. Thus Dr. Angelo Lama told me that in Faenza, at 21, Via Torricelli, Luigi Tassinari, his wife, a domestic servant, a cat and a dog had all died of cancer. The Veterinary Inspector of the Province of Ravenna informed me of a lady who had died of cancer of the uterus; she had a pet cat that died of multiple mammary cancer some weeks later. Professor Testi and Dr. Galli, in their work on Cancer in Faenza, mention a curious case. They say: "We may mention the case reported to us by Professor Fedeli concerning a man who, dying from cancer of the stomach, entrusted to his nephew two pet animals, a dog and a hen, which he had kept for several years in his own room and were dear to him. Some months later the dog died of a consumption, and was found to have a cancerous disease of the stomach and liver; not long after the fowl also succumbed to cancer of the œsophagus. Further, we may cite a case in our own practice of a gentleman of Faenza who died of carcinoma of the liver, when previously in his own family had died first a dog and later a maid-servant of a similar disease." On August 24th Dr. Ghetti drove me to see one of his cancer patients in the parish of Santa Lucia, Fondo S. Giovanni. This man, Giuseppe Dapporto, sixty-one years of age, had a dog twelve years old presenting a conspicuous mammary growth. Several farmers told me on inquiry that they had noticed new growths in cats, dogs, and especially in fowls.

were found in the meal-ark, an indispensable article of kitchen furniture present in all farmhouses. Besides cockroaches, I found in the meal-flour meal-beetles (*Tenebrio molitor* and *Tenebrio obscurus*), meal-moths (*Asopia farinalis*) and meal-mites (*Aleurobius farinæ*, *Tyroglyphus longior*). In the stables adjoining the living-rooms of farmhouses, beneath the alfalfa fodder-heaps, always I found cellar beetles (*Blaps gages* and *Blaps gibba*) and wood-lice (*Porcellio*), whilst mice, field-mice, and rats everywhere abounded. The two so-called " cancer houses " visited by me, one at Predappio, the other at Cotignola, the first adjoining a mill, the second a bakery, were both heavily infested with cockroaches and other meal-attracted vermin.

Now cockroaches, meal-beetles, meal-moths, cellar-beetles, and wood-lice all harbour within their body-cavity or musculature the encysted larval forms of various kinds of round and flat worms which spend their adult stage in the alimentary tract of domesticated animals and man. The most important are certain Spiruroidea of the genus *Gongylonema* and one or two small tapeworms of the genus *Hymenolepis*.

Gongylonema.

Nematodes of the genus *Gongylonema* are of special interest with regard to the ætiology of new growths. Professor Fibiger has shown that a species discovered in the stomach of rats and named by him and Ditevsen, in 1914, *Spiroptera neoplastica* (= *Gongylonema neoplasticum*) is a frequent cause of gastric carcinoma in rats. The quiescent larval form of the parasite was found encysted in the musculature of cockroaches collected in Danish sugar refineries whence the infected rats had come. The beetles belonged to the American species called *Periplaneta americana*, and probably had been imported with raw sugar from the Danish West Indies. By experimentally feeding healthy rats from other localities with *Gongylonema*-infested cockroaches, carcinoma of the stomach followed almost invariably.

Thirteen species of *Gongylonema* are already known to science: they have been found in man, ape, hedgehog, rat, mouse, jerboa, guinea-pig, rabbit, squirrel, ox, sheep, goat, horse, ass, camel, fallow-deer, hog, and domestic fowl. In some of these animals, such as cattle, sheep, and hogs, the filiform, sub-epithelial parasite was found to be exceedingly common when special search was made for it. In man four cases only have been recorded, all from the United States of America, since 1916, when Professor Henry Ward, of Illinois, demonstrated the first case. The patient, in this case, was an untravelled girl, aged sixteen, who had lived always in Jefferson, Arkansas. The worm was noticed on October 1, 1916, beneath the mucosa of the lower lip; it wandered actively to and fro between

lip and fauces after the manner of another Filarioidea, the well-known African *Loa loa*. It was removed by means of a needle by the attendant physician, Dr. Robert Lee Covington, of Jefferson, who sent it to Ward for determination. Ward's diagnosis was that the small thread-like worm belonged to the genus *Gongylonema*, and might possibly be *Gongylonema pulchrum*, a parasite of the hog, the larval form of which no doubt occurs in insects. He says :—

" The source of the infection in the case at hand cannot be positively ascertained, and yet recent studies sugges a very probable explanation. Thanks to the careful work of Ransom and Hall, which has extended over several years, it is now known that the larvæ of *Gongylonema scutatum* occur in various species of dung-beetles, and that they have been raised experimentally not only in these, but also in croton bugs, and at the close of a month embryos were found encysted in the final stage and ready for transmission.

" In the present case it is easy to see how an infected insect, very likely a croton bug, might have been ingested whole, or some fragments of it included by accident in meal, flour, milk, or other materials used in cooking. Such sanitary mishaps are very common with poorly prepared food, and thus the infection of the human host would have been achieved. The sanitary conditions noted in the clinical history of the case favour such an occurrence."

In 1917, Dr. C. Wardell Stiles described a second case of *Gongylonema* infestation in man. The parasite was found in the lower lip of a girl in Florida.

A third case was reported by Stiles in 1921 from Georgia. The worm, again a female, 35 mm. long, but unfortunately badly macerated, also came from the mouth of a woman who verged on the age of fifty.

A fourth case was reported by Ransom in 1923. It occurred in Louisiana.

Until adequate material from man be available to establish the specific characters, Dr. Stiles suggests, on purely practical grounds, the name of *Gongylonema hominis* for the species so far found in man.

Though hitherto overlooked or unrecognised, it is probable that *Gongylonema* occurs far more frequently than supposed both in man and domesticated animals, but physicians have not made search for it post-mortem, neither have our veterinarians looked for it at abattoirs. Yet the little knowledge we have of the occurrence of *Gongylonema scutatum* in our cattle and sheep does not necessarily mean that in Europe this parasite is absent or less frequent than in the United States of America, or in the North of Africa, where it has been looked for by such competent men as Stiles, Ransom, Hall, Seurat, Fayet, Boulant. Several examples might be quoted to show how easily

inconspicuous parasites may escape observation unless specially looked for. I need but mention the nymphal form of the cosmopolitan tongue-worm *Linguatula serrata* and the ray fungus (*Nocardia bovis*).

One might ask: "How is it that *Gongylonema*, if present in man in Europe, has never come under observation, as in the four American cases just quoted?" The retort also might be a question: "Why was it not noticed sooner in America?" But are we sure that it never was observed in Europe? I believe it was. Indeed, I am inclined to ascribe to the genus *Gongylonema* some old imperfectly described nematodes, such as the one discovered in 1864 by Professor Carlo Pane, of Naples, Italy. Pane's worm appeared beneath the epithelial covering of the upper lip in a Neapolitan medical student twenty years of age. On account of irritation and itching of two or three days' duration, the young man everted and examined his lip in a mirror, and, noticing something white moving beneath the epithelial layer, extracted it by means of a steel pen. The captured worm was brought to Professor Pane, who, considering it to be a *Filaria*, proposed to call it *Filaria labialis* on account of its site. It was a female worm of hair-like breadth, measuring 30 mm. in length. The anus was placed ventrally near the posterior extremity, and the vulva opened at 3 mm. from the caudal end. Four small papillæ were noticed about the mouth. Pane gives no further details, but a semi-schematic drawing of the parasite by a noted Italian naturalist, Professor Paolo Panceri, reveals other important features. There are a short vagina and two divergent uteri plainly visible; the anterior uterus and ovary longer than the posterior, a long œsophagus consisting of a slender anterior portion and thicker, longer posterior portion, and a somewhat blotchy outline, which, together with other vague indications of unevenness on the surface of the anterior portion of the body, suggest the characteristic longitudinal rows of large cuticular bosses of *Gongylonema*. This being so, the name of *Gongylonema hominis*, proposed by Stiles for the, as yet undetermined, species found in man, would become a synonym of *Gongylonema labialis* (Pane, 1864).

Doubtless in the near future *Gongylonema* will be found to occur frequently in man throughout the world. Probably, as in the case of *Hymenolepis nana*, it has been overlooked hitherto on account of its slenderness, transparency, and peculiar location. At one time the dwarf tapeworm (*Hymenolepis nana*), not more than 25 mm. long, was considered to be a rare accidental parasite in man, but Stiles pointed out that there were indications showing that, in certain parts of the world at least, it would be found to be the most common tapeworm of man. He was right. The hookworm campaign, in-

volving as it did a systematic and minute examination of fæces, incidentally brought it to light.

In their adult stage, *Gongylonema* worms select as habitat the œsophagus and cardiac end of the stomach, but they may be found in other parts of the body, as in the lips, tongue, or liver, the rumen in ruminants, and the crop in fowls. This peculiar location corresponds with the most common site incidence of cancer in man and animals.

If *Gongylonema* were indeed a factor in the ætiology of cancer in man, not only should we understand the peculiar site incidence of certain forms of the disease, but also the simultaneous occurrence of similar neoplasms in animals, wild and domesticated, the unequal topographical distribution of the disease and the observed association between cockroaches and cancer houses in certain districts. Moreover, cockroach bionomics would explain the occurrence of the disease in old buildings and its prevalence in low-lying, clayey, and damp districts, because these *Orthoptera* require not only warmth and darkness, but moisture especially.

Against any possible correlation between cancer and cockroach, someone probably might object by again adducing the twice-told tale of the insect's recent introduction into Europe. But this story of recent importation is based on a mistake of interpretation, repeated by all compilers of entomological text-books since White of Selborne told us, in 1790, that, prior to that date, he had never observed cockroaches in his house, but could not tell how long they had abounded in England. Of course the incidence of cancer goes back to time immemorial, and I believe I have myself adduced some interesting and important evidence in support of its great antiquity. The common cockroach is fully as ancient in this country and other parts of Europe. Indeed, the discovery of wild specimens in the Crimean peninsula, living under dead leaves, vegetable detritus, and stones in woods and copses far from any human habitation points to Caucasia as possibly its cradle land, unless it be a case of reversion from domesticity. The common cockroach is described and figured in unmistakable way by Thomas Moffett in his famous book on insects, published in 1634, many years after his death, and by the Italian, Mattioli, in his *Commentaries on Dioscorides' Materia Medica*, published in 1548, also by Aldrovandi and others, who in turn quote Greek and Latin authors, such as Pliny the Elder, to whom the fœtid "black-beetle" was well known as a bread-eater and polluter of meal. However, we should not forget that besides cockroaches, darkling-beetles (*Tenebrionidæ*) and Dung-Beetles (*Scarabæidæ*) may foster *Gongylonema* larvæ. Indeed, certain coprophagous beetles seem to be their normal hosts.

OTHER HELMINTHS.

But though *Gongylonema neoplasticum*, as shown by Fibiger, may certainly bring about carcinoma in the stomach of rats, it does not seem to be the sole parasite able to induce the formation of malignant new growths in these rodents. Already, in 1906, Borrel had incriminated *Cysticercus fasciolaris*, the larval form of the cat's thick-necked tapeworm (*Tænia tæniæformis*) as a cause of sarcoma of the liver in rats and mice. His suggestion was based on the fact that primary sarcomatous tumours occurred in the liver and other organs of rats infested by the larvæ of the cat tapeworm. He did not consider the bladderworm to be the actual cause of cancer, but looked upon it as a possible carrier of some cancer microbe as yet unknown.

Four years previously Regaud had published two cases of malignant growth associated with bladderworms in rats. The first, a female rat with mammary tumour and secondary peritoneal carcinosis, presented, on the free border of the liver, a cyst containing a living cestode larva. On this cyst, as also upon the various organs, were found cancerous nodules. The second rat had an omental tumour within a cavity of which lay a coiled-up strobilate larval cestode 25 cm. long.

At the Tunis Pasteur Institute, Bridré and Conseil, on examining 2,000 wild rats (*Rattus norvegicus*) found sarcoma of the liver in five of them. Four of these tumours enclosed each a cyst containing a cestode larva (*Cysticercus fasciolaris*). The bladderworms were embedded in the new growths which belonged to the spindle-celled type of sarcoma.

In 1911–12 Woolley and Wherry examined 23,000 American wild rats, and found three with liver sarcoma each with a *Cysticercus* in the growth.

In 1913, Borrel again insisted on a connection between *Cysticercus fasciolaris* and a typical cancerous tumour of rats which can be transplanted in series. He pointed out that the bladderworm often is found in the very centre of the tumour, and claimed that observations by Regaud, Saul, McCoy, Bridré, and others supported his view of the ætiological importance of *Cysticercus fasciolaris* in the incidence of sarcoma in rats and mice. Bridré had examined no less than 20,000 rats, and had found the bladderworm in 8,000, a proportion of 40 per cent. Of these parasitised rats only twenty presented sarcomatous growths, but invariably the *Cysticercus* was lodged in the very centre of the tumour. In one instance Bridré had been able to witness the very beginning of the sarcomatous growth—intra-hepatic nodules no larger than ordinary shot, in each one of which

he had found a tiny cestode larva surrounded by typical sacomatous tissue.

Some years ago I examined about 800 rats (*Rattus rattus, Rattus norvegicus*) captured by rat-catchers at the London Meat Market, the London Docks, and on board ships hailing from various parts of the world. In many of these rats I found *Cysticercus fasciolaris*, but I cannot recall a single case of sarcoma in the liver of the parasitised animals. In one rat (*Rattus rattus*) from the Albert Docks the liver was so crammed with bladderworms that the hepatic tissue was almost obliterated, yet there was no evidence of cancer. In all rats and mice examined by me the *Cysticercus* was limited invariably to the liver. A few negative observations such as these have little value and do not disparage Borrel's interesting and suggestive indication.

In 1920 Bullock and Curtis produced a large number of cases of sarcoma of the rat's liver by the simple expedient of feeding rats with the ova of *Tænia tæniæformis*: the tumours arose from the encapsulating tissue surrounding the bladderworms (*Cysticercus fasciolaris*).

Another parasite of man likewise incriminated by Borrel as a possible vector of the cancer germ is *Demodex folliculorum*, a microscopic vermiform acarine which, head downwards, infests the hair-follicles and sebaceous glands, especially on face, alæ of nose, forehead, lips, and chin. I have found it in comedones on the scrotum and penis of a syphilitic middle-aged chimney-sweep. If, as suggested by Borrel, this minute acarus is truly instrumental in producing new growths, possibly it might explain the frequency of cancer of the scrotum in chimney-sweeps, because comedones seem to be particularly common about the genitals of men who work in soot and coal-dust.

Teulschlaender reports the formation of cancroids on the legs of fowls previously affected by "scaly leg." This latter highly contagious disease is caused by a minute acarine—*Cnemidocoptes mutans*—which burrows within the skin, excites the cells to multiply, raises the scales, and accumulates crusty exudates which give the legs a swollen, rough, unsightly appearance. These lesions, like those of human psora, are invariably complicated by bacterial infection.

Other helminths, especially Trematodes (*Schistosoma hæmatobium, Schistosoma mansoni, Opistorchis felineus, Clonorchis sinensis, Hepatica hepatica*, etc.), have long been looked upon as possible factors in cancer incidence, and not without reason; still we must be careful not to confound mere coincidence with a possible relationship.

If any of these or other worms do play a part in the ætiology of cancer, it can only be one of portage. They must act as carriers

of some cancer-germ as yet unknown. Possibly the lesions to which they give rise may favour the penetration of the germ, or in some way prepare a suitable soil for its development. The peculiar galleries pierced by *Gongylonema* through and beneath the squamous epithelial covering of the gastric and œsophageal mucosæ, so like those of the itch mite in the corneous layer of the skin, seem almost "streaks" for the culture of cancer germs. Thus, worm, specific germ, and the varied bacterial flora which usually follow, constitute a kind of metabiosis—a process well known to early man, who not only understood it, but mastered it, controlled it, and applied it with wonderful acumen to the production of commodities such as cheese, wine, and vinegar.

Blackhead.

An instructive example is furnished by the so-called blackhead, a disease of turkeys, barn-fowls and other birds, caused by a protozoal organism—*Histomonas* (*amœba*) *meleagridis*—discovered by Theobald Smith in 1895. The protozoon invades the cæca and liver of its avian host, often giving rise to a fatal entero-hepatitis. Experiments carried out by Smith and Graybill, in 1920, showed that the incidence and gravity of the disease could not be explained so simply as was at first surmised, but that probably some additional factor was involved in the transmission of blackhead. Indeed, whilst feeding young incubator-reared turkeys with the fæces of old ones which had passed successfully through exposure to the disease gave negative results, soil recently occupied by old turkeys was infectious to the young experimental birds. Two cæcal parasites—a coccidium (*Eimeria avium*) and a nematode (*Heterakis papillosa*)—suggested themselves as possible coadjutors. The coccidium, confounded by some with the specific amœba, invades the epithelial cells, while the histomonas is purely a connective-tissue parasite. The experiments which followed, however, incriminated the worm.

"Blackhead was produced in healthy incubator-raised turkeys, reared in the open in an environment where blackhead occurred, but without direct contact with old turkeys and other poultry, by feeding cultures of embryonated eggs of *Heterakis papillosa*, whilst it was not possible to start the disease by feeding incubated fæces or cultures from which the worms and ova had been removed."

Smith and Graybill have not defined yet the exact part played by *Heterakis papillosa* in the transmission and pathogenesis of histomonas. They say:—

"The production of acute blackhead by feeding embryonated eggs to turkeys in whose cæca adults of *Heterakis papillosa* are already present seems incomprehensible at first thought. A tentative explana-

tion is that the worms, when invading the cæca in large numbers, break down the resistance of the bird."

Whilst working at the Prosectorium of the London Zoological Society's Gardens in 1907, on several occasions I found species of *Heterakis* in the cæca of pheasants and other birds. The cæcum wall of a Manchurian eared-pheasant (*Crossoptilon mantchuricum*) is literally crammed with small cyst-containing nodules, in each of which a more or less immature specimen of *Heterakis isolonche* was enclosed. These peculiar cysts in the cæca of pheasants infested with species of *Heterakis* were described by me in a paper on "The Part played by Metazoon Parasites in Tropical Pathology," read at a meeting of the Society of Tropical Medicine and Hygiene, December 20, 1907. I endeavoured to show, from my personal observations on *Ascaris, Agchylostoma, Œsophagostomum* and *Heterakis*, that the route followed by intestinal parasites was not, in all cases, a simple direct slide down the alimentary tube with water or food, as then supposed, but that the majority of these parasites entered the body of their host, either through the skin or through the mucosa lining the upper part of the digestive tract, then travelled by way of the blood-stream, or through connective tissue, often encysting for a time to undergo development before finally reaching the anatomical habitats in which they usually are found after attaining maturity. Thus it is that we find the immature forms of *Heterakis* encysted in the cæcal submucosa, from which, on reaching maturity, like the immature forms of *Œsophagostomum*, they escape into the cæcal cavities to conjugate and oviposit. The lesions produced by these worms no doubt give the blackhead protozoon its opportunity.

Whilst incriminating *Cysticercus fasciolaris* as a possible factor in the ætiology of hepatic carcinoma in rats and mice, Borrel pointed out, as surest proof of his conjecture, that, as a rule, the bladderworm was contained within the new growth. In the case of gastric carcinoma, ascribed to the agency of *Gongylonema neoplasticum*, Fibiger also states that he has found the worm embedded in some of the primary growths, but never in any of the secondary growths or metastases. But the permanence of the worm in the new growth is unnecessary, since doubtless its part is that of carrier and sower; the sowing done, it has no further concern in the development of the tumour. A parallel case is that of filarial elephantiasis, in which, almost invariably, the worms having started the growth, die and disappear.

Elephantiasis.

In view of the working hypothesis I am suggesting, let me briefly recall the history of the elucidation of tropical elephantiasis, because

of the light it throws on the ætiology of cancer. First mentioned by Lucretius as "*Elephas morbus*" in his poem "On the Nature of Things"; well portrayed by Rhazes and Avicenna, tumorous elephantiasis finds an excellent exponent in Hillary of Barbados, who, in the middle of the eighteenth century, clearly perceived the part played by lymphangitis in the building of it. Then Wücherer, Lewis, and Bancroft successively discovered the various stages of the nematode worm—*Filaria bancrofti*—which gives rise to it, whilst Manson demonstrated its disseminating agent—the mosquito. Before Manson's discovery, elephantiasis, just like cancer to-day, was looked upon by some as a hereditary diathesis, by others as a directly contagious disease, whilst the majority of physicians speculated on various food causes, ascribing it in turn to the eating of pork, stock-fish, or water-fowl, to some tropical fruit, such as the fragrant *Keura* or *Kaldera* (*Pandanus odoratissimus*), or to the drinking of stagnant water or swizzled cocktail. It was Manson who pointed out the relationship between filariasis and elephantiasis.

Filarial elephantiasis is unequally distributed. It ranges throughout the tropical and subtropical belts, extending north as far as Sicily and Southern Spain in Europe and Charleston in the United States of America; south as far as Brisbane in Australia; but its prevalence varies considerably from place to places, as does the prevalence of cancer. Whilst absent in some places, in others elephantiasis affects more than 50 per cent. of the population. Of places with highest incidence one might mention Amoy in Southern China, where Manson made his momentous discovery, Samoa, one of the Navigator Islands, in the Micronesian chain, and Cochin in Southern India. In the itinerary of his voyage to the East Indies, published in 1595, Jan Huygen Van Linschoten gives a picture of "Cochin leg" as he saw it on the Malabar coast during the five years he spent at Goa; it is the earliest drawing of elephantiasis that I have been able to find. In the West Indies elephantiasis is very common in some of the islands, as in Barbados, where it used to be called the "Barbados leg," or the "glandular disease of Barbados," and where, in 1913, I found it still unpardonably prevalent. In other neighbouring islands, such as Grenada, it is unknown. Whilst travelling through British Central Africa, Daniels found filariasis and its attendant elephantiasis to be very common at the northern end of Lake Nyassa, but at the southern end he met with only one case of filariasis and no elephantiasis.

We now know that filariasis is transmitted by mosquitoes belonging to several genera (*Culex, Ædes, Tæniorhynchus, Anopheles*). These act as necessary intermediate hosts, and the relationship is so won-

derfully adapted that when the mosquito host is a night-biter, the microfilariæ, though still enclosed in their egg-membranes, like boys in a sack-race, actively leave the lungs and come swarming into the peripheral circulation, at night time, to meet their liberators. Where it is a day-biter, or in places where both night- and day-biting species are acting concurrently, the periodicity of the sallies is altered to suit circumstances. This amazing correlation, between the young of the parasitic worm within the body of the vertebrate host and their insect nurse in the outer world, is analogous to many similar relationships which have become established between pathogenic protozoa and their arthropod disseminators, or between flowers and pollenating insects. Many flowers which open early in morning are visited only by particular butterflies which leave their nocturnal haunts at the same hour; other flowers do not open until sunset, and they are visited by hawk-moths, silk-moths, owlet-moths, and other *Noctuæ* which commence their ramblings at dusk. Then, again, the emitting of flower scent is simultaneous with the flying time of certain insects. The flowers of *Hesperis tristis*, as well as other flowers visited by small nocturnal moths, give off no scent during the day, but exhale a strong alluring hyacinth odour at twilight; on the other hand, many flowers visited during the day become scentless at night.

After a quiescent stage of growth and metamorphosis spent between the thoracic muscles of the mosquito, the filariæ actively migrate to the insect's head and make ready to emerge by piercing the most delicate parts, either the membrane which connects the chitinous pharynx to the base of the hypopharynx, as I have seen, or after entering the labium, the membrane between the labellæ, as Dutton and Lebredo have shown. The escaped filariæ now get on to the surface of the skin, penetrate the tissues, and reach the lymphatic vessels. Here they pair, attain full maturity and oviposit. As a rule, like other filarids, they cause little or no harm, but, not infrequently, by obstructing lymphatic trunks, they may give rise to various pathological conditions, such as lymphatic varices, adenitis, chyluria, chylocele, chylous ascites, orchitis, abscess, and elephantiasis. These morbid conditions have been explained by Manson as due to lymphostasis brought about by obstruction of lymphatics. A single worm, a bunch of tangled worms, or the prematurely extruded ova of a dilacerated female filaria, he considered, might be the cause of obstruction. This explanation, which has been accepted very generally, no doubt is correct, but insufficient. It assigns undue importance to the filaria and neglects the essential repeated attacks of streptogenes inflammation. Associated with certain ubiquitous bacteria (*Coccaceæ* of various kinds) is a necessary factor in the

ætiology of all filarial diseases, each one of which may occur independently of filariasis, though they are certainly met with far more frequently in filaria-infested persons, whilst their prevalence obviously is strictly dependent on the greater or less prevalence of filarial endemicity. From the very first, whilst leaving the mosquito's mouth-parts and wriggling over the surface of a man's skin, the filaria is likely to become covered with bacteria. Certainly, lymphangitis or erysipelatoid fever—Fayrer's "elephantoid fever," the so-called fever and ague of Barbados"—is the prelude to all forms of filarial disease. Elephantiasis, the most prominent of these, invariably is ushered in by attacks of lymphangitis, recurring again and again until mammoth growths result. One such tumour of the scrotum weighed 224 lb. That elephantiasis usually is a "filarial disease" is well proved by the excessive prevalence of the disfiguring growths within filaria stations and their great rarity elsewhere.

Recapitulating, in the case of elephantiasis, we have :—

First, several mosquitoes capable of fostering and disseminating the larval forms of *Filaria bancrofti* within those parts of their combined distributional areas in which temperature and other œcological conditions are favourable to the worm's development.

Secondly, the adult filaria inhabiting the lymphatic system of man, sacculating the vessels in which they nestle, and occasionally obstructing them.

Thirdly, certain ubiquitous micro-organisms (*Coccaceæ*), possibly carried into the lymphatic vessels by the filariæ at the time they invade their human host, giving rise to repeated attacks of lymphangitis and gradually producing those enormous and hideous tumours which we call elephantiasis or pachydermia. These bacteria soon kill off the worms, hence microfilariæ are found seldom in cases of elephantiasis.

Also in certain forms of cancer, if I interpret observed facts rightly, we may have :—

First, certain cockroaches, meal-beetles, and possibly also dung-chafers, capable of fostering and disseminating the young stages of a spiruroid worm of the genus *Gongylonema*.

Secondly, the mature *Gongylonema* inhabiting as a rule the alimentary tract and more particularly long galleries pierced in the stratified squamous epithelium lining the œsophagus and the cardiac end of the stomach.

Thirdly, some ubiquitous micro-organism, possibly ultra-microscopic, which, favoured by the activities of the worm, may invade the tissue cells and give rise to malignant growths.

THE IRRITATION THEORY.

However different may be the views hitherto expressed concerning the causation of cancer, on one possible factor there seems to be a general agreement—that is the importance of irritation. Yet, with regard to the nature and mode of action of the irritant there is great diversity of opinion.

Let us endeavour briefly to examine the mass of conflicting evidence before us, classifying it as far as possible.

Two principal modes of action are to be considered: the sudden, single, intense blow, and the long-continued or oft-repeated irritation.

Let us consider first the blow. it is stated that single severe injuries, such as blows and fractures, have frequently been followed by the development of neoplasms.

"GONGYLONEMA NEOPLASTICUM," NATURAL SIZE. (AFTER FIBIGER.)

The female breast, on account of its exuberant development and exposed position, is injured so easily by blows that public opinion, confirmed by Courts of Justice, considers the blow a very likely cause of cancer, no matter how many years have passed between the infliction of the injury and the manifestation of the disease. But consider: what woman has not received an accidental blow upon the breast in the course of her life?

Statistics show that about 10 per cent. of patients with malignant mammary tumour can and do assign a definite injury as the initial cause. But we should not forget that whilst contusions and injuries of the breast are common in women, only a small proportion of such accidents are followed by malignant tumours, and that, whilst all women are liable to blows, the comparative frequency of cancer of the breast varies greatly in different parts of the world; thus, for example, the English rate (17·9) is nearly ten times greater than the rate for Japan (1·8). Surely wife-beating is not more common in merry England than in "Dai-Nippon," where, from early times, unchivalrous mal-estimation has surrounded the sweet, gentle, soft-voiced, unselfish "daughters of the Rising Sun." Then, again, it is not carcinoma that follows the blow, but sarcoma, a far less common tumour of the breast. Surgeons see many patients suffering from sarcomatous and carcinomatous tumours who cannot recall any injury to the affected part, and, though inclined to believe that a single blow occasionally may determine the development of a malignant growth, in their writings they seem loth to express any definite opinion as to a causal relationship between blows and cancer.

The great majority of blows do not give rise to tumours, and in most cases of injury followed by cancer, the connection, to say the least, may be accidental. Certainly it would be difficult to find a starting-point for cancer upon or over which the patient could not remember having received a blow or injury of some sort within the two or three years preceding its appearance.

Many cruel, unnecessary experiments have been performed on old bitches either to prove or disprove the agency of traumatism in the causation of malignant tumours. The animals have been subjected to repeated blows upon the mammary region and other parts of the

EGGS OF "GONGYLONEMA NEOPLASTICUM."
(AFTER FIBIGER.)

body during several months, yet though inflammatory swelling necessarily, and abscess sometimes, followed, no new growth ever was produced, notwithstanding that dogs are prone to cutaneous epithelioma and more especially to mammary cancer.

No doubt at times the single blow may prove a predisposing or determining factor in the development of a neoplasm, but the evidence adduced is, if anything, adverse to any direct causal relationship. Who knows not that tuberculosis of bone may develop after an injury? But a blow cannot engender Koch's bacillus; it merely ruptures an encapsuled focus which up to the time of injury had produced no symptoms. Is it not possible that when a sarcoma develops at the seat of a fracture, or a carcinoma of the stomach follows a blow dealt on the gastric region, the neoplasm was already

present at the time of the injury, though as yet not made manifest by any symptom ?

Epithelial cysts in the palm of the hand arising from torn pieces of skin carried into the deeper tissues by knife or shot have been adduced as examples of tumours caused by a single trauma, but surely cysts have no relation whatever with true neoplasms.

Now let us consider the agency of chronic irritation. Greater importance has been assigned to continued or frequently repeated local irritation, either mechanical or chemical, in the causation of cancer. It is claimed that most tumours appear after long-standing irritation which brings about inflammatory reaction involving long-recurring destruction and regeneration of tissue.

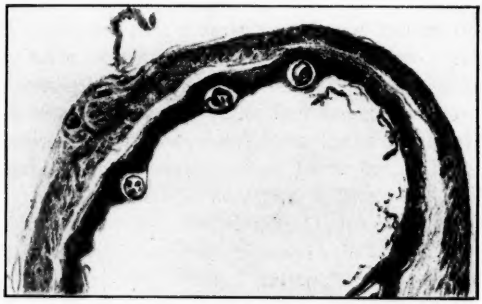
The various irritants incriminated are innumerable. I need mention but a few to give some idea of their diverse nature. Thus we find mentioned : contracting scars and carious teeth ; pressure of pipe-stem in man ; pressure of tight-laced corset in woman ; changes produced by light, X-rays or radium ; by coal, tar, pitch, naphthalene, aniline dyes, petroleum, vaseline, tobacco, arsenic, soot, or manure ; the dust from metal factories or spinning mills ; certain diseases such as chronic endometritis, phimosis, psoriasis, leukoplakia, syphilis, and tuberculosis cutis ; betel-nut chewing, scalding drinks, coarse, irritating foods, badly fitting tooth-plates and kangri-burns.

It would be long and tedious to discuss all these and the many other causes of cancer. We need consider but a few examples illustrative of the various types of irritation. However, in a general way, it is well to remember that against each case in which one or other irritant appears to be the essential factor, there are thousands more in which the very same irritants never give rise to cancerous formation.

Pipe, Lip-plug, and Bit.

Pressure of the pipe-stem long has been considered a plausible cause of epithelioma of the lip in man, but this growth also occurs in smokers of cigars or cigarettes, and many cases have been reported in non-smokers. Often, instead of appearing in the pipe situation, it is found in the median line, or on the side of the mouth opposite to that usually occupied by the pipe. Some incriminate the long, heavy pipe, others the short cutty pipe, which, held firmly between the lips without support from the hand, conveys a painful degree of heat. Sir John Bland-Sutton points out that while cancer of the lip sometimes is spoken of as " countryman's cancer," on account of the frequency with which it occurs among agricultural labourers who use dirty clay pipes, " many professional men, including the vicar of the parish, smoke as hard as the labourer, yet it is excessively rare

to find a case of cancer either of the upper or lower lip among them." The American Indian is said to be practically immune to cancer, yet he has always been a great pipe-smoker. Was it not he who first taught us the use of the " saintly herb," or " devil's weed " ? Was



TRANSVERSE SECTION OF RAT'S ŒSOPHAGUS SHOWING "GONGYLONEMA" IN SITU. (AFTER FIBIGER.)

it not he who passed to us the beautifully carved stone-pipe which he had been smoking for centuries preceding the landfall of Colombus ?

Was there no cancer of lip or tongue in this country previous to Raleigh's introduction of the noxious smoking habit ?

TUBEROUS TUMOUR IN STOMACH OF RAT INFECTED WITH "GONGYLONEMA NEOPLASTICUM" (AFTER FIBIGER.)

And what about the use of labrets or lip-plugs so widely distributed throughout the world and perpetuated since time immemorial ? The Tlinkits of Alaska, the Eskimo, further north, the Botocudos of East Brazil, the African women along the Nile and the Zambesi and around

Lake Stefanie, all pierce or slit their lips and gradually stretch the openings by successively inserting wooden pegs of large dimensions as the lip apertures become more distended. Thus, discs of wood, shell, ivory, glass, quartz, or metal, 2 or 3 inches in diameter, may be seen fixed stud-like in the upper lip, while cylindrical pendants, often weighing a quarter of a pound, drag, elongate, evert the lower lip, hideously exposing teeth and gums. There can be no doubt as to the irritation caused by these strange ornaments, which often turn the upper front teeth inward by their pressure. Yet never have they been accused of producing anything more serious than comicality, especially when the duck-billed girls start chattering and laughing. Furthermore, with regard to pressure of a short clay-pipe stem, considered as a possible cause of epithelioma of the lip, does the constant irritation produced by the bit in the mouth of horses give rise to malignant tumours either of tongue or lips ?

Corset and Foot-binding.

Long ago it was suggested by Oelsner, and repeated by others, that pressure exercised by a tight-laced corset might cause cancer of the breast in women, but the several cases I have seen among West Indian negro women, who wear hardly anything around their chests, does not support the corset theory of mammary cancer, neither have we any evidence to prove that cancer of the breast was more prevalent between the sixteenth and nineteenth centuries when this beautiful part of the female body was tightly stayed in Greenland whalebone, Brazil cane, and bars of steel.

The Unknown Germ.

It may seem idle to speculate on the nature of a possible cancer germ when general opinion seems adverse to any parasitic cause, and, instead of grouping cancer with the granulomatous diseases, such as syphilis, tuberculosis, leprosy, verruga, and granuloma fungoides, which it most resembles, endeavours to see in it fantastic unused embryonic remains, suggested by the teratomas, which never should have been mixed up with malignant neoplasms. Of course, some teratomas occasionally may assume the appearance of malignant tumours, but only when a real malignant new growth invades them and extends into the patient's tissues. Certainly, the unequal topographical distribution of cancer throughout the world strongly indicates a biological cause, and idle is the objection that failure to demonstrate the true causal organism means that there can be no such organism. The history of tuberculosis, that of syphilis, the history of many other diseases, now proved to be of parasitic origin,

should teach us caution in expressing a contrary opinion, especially when we cannot propound a theory of cause capable of explaining all the facts. Consider the case of yellow fever, once ascribed to earthquakes, insolation, atmospheric electricity, want of acclimatisation, excessive indulgence in food and drink, soil effluvia, and a thousand and one parasites belonging to the bacteria, the fungi, and the protozoa. The latest organism incriminated—Noguchi's *Leptospira icteroides*—may or may not be the true causative agent in yellow fever, yet, long before, from analogy, believing it to be an endemic

"ELEPHAS MORBUS."
(Photograph by Dr. Sambon, British Guiana).

infective disease, the epidemiologist had sought, found, and actually subjugated the all-important intermediate agent—the Ædes mosquito, which determines its peculiar localised distribution—and thereby has stayed the deadly scourge. The cleansing of Havana, the sanitary transformation of the Panama Canal Zone, are striking examples.

If it be true that the most diverse forms of irritation, animate and inanimate, may give rise to cancer, then surely the cancer germ must be some frequent and ubiquitous micro-organism, like the germ or germs which, in association with *Filaria bancrofti*, or some like factor, bring about those enormous tumour-like formations we call elephantiasis and pachydermia.

Failure hitherto to find the cancer germ may have been due to faulty technique or to extreme minuteness. Recently, indeed, Rous and his fellow-workers have found that chicken tumours of connective tissue type may be reproduced in healthy fowls of the same breed by the injection of cell-free extracts of these tumours.* In each case the neoplasm produced in the inoculated fowl resembled the tumour from which the extract was made. This shows that the type of tumour is determined by the individuality of the causative agent, and not alone by the potentialities of the stimulated cells. The work of Rous and others seems to show that particular neoplasms have specific causative agents which in some cases can be separated from the neoplasm. They appear to be living ultramicroscopic organisms able to pass through a Berkefeld filter impermeable to *Bacillus fluorescens liquefaciens*. Already several diseases have been shown to be due to so-called filtrable viruses. In most cases the unknown germ is transmitted by some intermediate host, such as mosquito, body-louse, or stable fly.

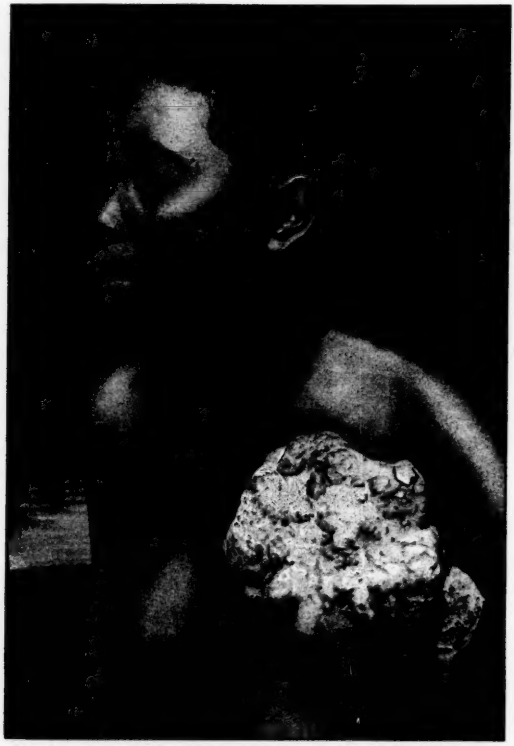
A Rebellion of the Cells.

But is it not the cancer cell itself which produces both primary and secondary tumours? Has the pathologist not proved that the cancer cell is nothing more nor less than one of the ordinary tissue cells which, suddenly having freed itself from the co-ordinating influences of the organism, starts on an independent career of lawless development, multiplying in a frenzied way and building huge, shapeless masses composed of disordered elements more or less resembling the cells of the tissue from which it sprang? "It is a mutiny or a rebellion of the cells," said the late Sir Jonathan Hutchinson. "A revolt against all cytological laws." The presence of the riotous cells is resented and resisted by the tissues among which they lie, exactly as if they were alien growths; but they are resistless, they displace the normal cells, penetrate into the spaces of the surrounding tissues, permeate the lymphatics, and travel by way of the bloodvessels. Follow the onrush of the anarchistic cells, and you shall see them move ruthlessly along, penetrating even bone and marrow, growing at the expense of the organism which, finally, they inevitably destroy.

As early as 1835 Johannes Müller looked upon the cancer cell as a kind of parasite, and, indeed, like parasites, the cancer cells become disseminated through the system, forming colonies wherever they find lodgment. But if the cancer cell is a tissue cell gone mad, what is it that changes so profoundly its behaviour? To my mind its hasty,

* Also by means of the dry powder of cancer tissue.

disorderly, continuous proliferation suggests a minute living organism lodged within the cell. Nothing could account more plausibly for the remarkable, abnormal, proliferative activity which is the essential characteristic of the cells of malignant growths and the surest evidence of defence against attack. A striking analogy is exhibited by a



FUNGATING CARCINOMA OF LEFT BREAST IN A NEGRESS OF GRENADA, WEST INDIES.
(Photograph by Dr. Sambon.)

disease of plants called crown gall. Here the growths which occur on root or shoot are made up of irregular masses of round or spindle-shaped cells of reduced size, which grow and divide just like those of animal tumours. By means of continuous chains of cells from the primary growths, secondary tumours are formed, and these reproduce the structure of the tissues in which the primary growth developed. Thus we may find lignin in a leaf tumour, just as we may find bone out of place in malignant animal tumours. Owing to the work of

Erwin Smith and others, we now know that crown gall is due to a definite organism, the *Bacterium tumefaciens*, which has answered to Koch's postulates. "This organism occurs only inside of certain of the proliferating cells. When the cell divides, the organism is carried over into the daughter cells, in at least a part of which it multiplies. It occurs in the cell in comparatively small numbers and, owing to the granular nature of the protoplasm, cannot be made out satisfactorily even with high powers of the microscope." As in the case of rapidly growing animal neoplasms, so also in crown gall, the fully developed tumour falls a prey to saprophytic bacteria and fungi, becoming an open septic wound.

I am inclined to look upon the endocellular cancer germ as a dominant semi-symbiotic organism which can compel the invaded tissue cell to act as a parasite. Changes of habit equally profound are witnessed in other cases of symbiosis; thus the Rhabdocœla are greatly modified by their symbiotic algæ. Convoluta, once a carnivorous worm, has developed marked heliotropic movements, and now lives at the surface of tide-pools after the fashion of green plants. Symbiosis is widely spread throughout organic nature, and many are the protozoa containing one-celled algæ or bacteria in their single-celled bodies. Who knows not the association of *Chlorella vulgaris* and *Hydra viridis*, of "yellow cells" (*zoöxanthellæ*) and radiolarians, of green or blue-green algæ and fungi, forming that large, striking group of compound plants called lichens?

The Only Way.

Wading through the vast literature of cancer, we find far more speculation than observation concerning its causation. Fantastic inventions innumerable we find, which have served no other purpose than that of leading us away from the direct path of biological research. Cancer students seem to have forgotten that the greatest discovery of modern science is the knowledge of the fact that definite plants and animals cause disease, while this knowledge, already in a number of cases, has supplied us with appropriate means of prevention.

I believe that the malignant neoplasms should be inscribed on the tablets of Parasitology. What evidence is there *against* their extrinsic infective nature? Like other infections, are they not local in their initial stages? Are they not favoured by local lesions and lowered resistance? Do they not gradually infiltrate the adjacent tissues? Do they not affect the proximate lymph nodes? Do they not become generally disseminated by way of the lymphatics and bloodvessels, leading finally to constitutional disturbances—the cancerous cachexia of old writers? Indeed, have we not found at

times innumerable metastatic foci—a " miliary carcinosis " in every way similar to " miliary tuberculosis " ? The surgeon, has he not seen cancer recur after removal, possibly himself having fouled the field of operation ? * On the other hand, have we not seen tumours spontaneously retrograde ? Are they not combated, limited, overcome by the resisting forces of the organism just like other infections ? Why obstinately close our eyes to the strikingly unequal topographical distribution of the disease which points so strongly to a biological cause ? Why ignore the teachings of its wide zoological distribution—a distribution so similar in extent of species to that of tuberculosis, trypanosomiasis, diphtheritis, and plague ?

My researches have taught me that, like malaria, sleeping sickness, relapsing fever, elephantiasis, and plague, so also cancer has a complex natural history unsuspected or strangely ignored by the laboratory investigator. Its study is the work of the epidemiologist and the field naturalist. The question of cancer is a grave and urgent problem ; its solution a task truly stupendous.

A NOTE ON *GONGYLONEMA*, A NEMATODE PARASITE OF RUMINANTS AND OTHER ANIMALS.

By H. A. BAYLIS, M.A., D.Sc.,

Department of Zoology, British Museum (Natural History), South Kensington.

Gongylonema is a worm apparently not very well known to veterinarians in this country, and Professor Hobday has suggested that a note on it may not be without interest to readers of this Journal. Many species of *Gengylonema* have been described from different animals, chiefly mammals, but in the writer's opinion, after a detailed study of several of them, the number of valid species must be considerably reduced.

The form usually found in sheep, goats, and cattle, which has been named *Gongylonema scutatum*, and is also frequently referred to as *Spiroptera scutata*, appears to be identical with *G. pulchrum* of the pig, and, since the latter name was used some years earlier, it should be taken as the name of the species. What appears to be the same form is also found, though rarely, in camels, horses, and donkeys.

The adult worms inhabit sinuous galleries or burrows which they form in the thickness of the mucous membrane of the œsophagus, mouth, pharynx, or, more seldom, of the stomach, of their host. Although sometimes attaining a length of about 4 inches, they

* This is known as " post-operative cancer infection."

are very slender and not very conspicuous, unless present in large numbers, and may be readily overlooked in a hasty inspection of the œsophageal lining. When fresh they often have a slight pinkish tint. They do not appear to cause any inflammation of the organs affected, or, indeed, to give rise to any clinical signs at all. However, a very closely allied, if not identical, worm has been shown by Fibiger to be instrumental in the production of carcinoma of the stomach in rats, and it seems quite possible that, were they more often permitted to reach a suitable age, other animals might suffer in a similar way. In rats the worms have frequently disappeared before a recognisable neoplasm has developed.

The eggs of the worm reach the exterior with the droppings of the host, and the life-history can only continue when these eggs are swallowed by one of several insects capable of acting as intermediate hosts. In the insect host the larva hatches, and eventually becomes surrounded by a cyst or capsule, either in the body-cavity or among the connective tissue or muscles. Ruminants apparently become infected by accidentally swallowing various beetles or their larvæ—species of *Blaps* ("cellar-beetles"), which frequently occur in stables and cow-houses, or certain dung-beetles common in pastures. In the case of rats, the usual intermediate hosts are cockroaches and meal-worms, or the beetles of which the latter are the larvæ, and it is highly probable that cases of human infestation with *Gongylonema* are due to the ingestion of one or other of these insects.

Gongylonema pulchrum (or *scutatum*) occurs commonly in various parts of the world, having been recorded in Germany, Austria, Italy, Algeria, India, the United States, and Australia. Records of its occurrence in Great Britain are very scarce or non-existent. In view of its possible connection with cancer, it is important to know how common it is, and it is chiefly for this reason that it is thought desirable to draw attention to the parasite, in the hope that veterinarians may be induced to look for it. Another species, *G. verrucosum*, occurs in ruminants, but has only been recorded from India. Another, *G. ingluvicola*, occurs in the crop of fowls in America and elsewhere, but does not appear to have been found yet in this country.

The writer will be very grateful for any information relating to the occurrence of *Gongylonema* in any part of the world, but more especially in the British Isles, or for any specimens, which may be sent to the Natural History Museum, South Kensington, London, S.W. 7.

SOME NOTES ON SURRA IN THE CAMEL, ITS TREATMENT AND PREVENTION.

By Major V. C. LECKIE, D.S.O., M.R.C.V.S.,
Royal Army Veterinary Corps.

(*Continued from* p. 352, 1925).

The Phenomenon of Fainting at the Commencement of Treatment.

Experience has shown that camels do best under treatment if the initial doses are given when no trypanosomes are found in the blood. It would appear that "fainting" under treatment, and sometimes death, occurs in camels that present large numbers of trypanosomes in their blood at the time of injection. (See notes under treatment by sodium antimony tartrate and its value in clearing the peripheral circulation of trypanosomes.)

This phenomenon may occur even with very small doses of a ½ per cent. solution of tartar emetic, and with as few trypanosomes as three per field under one-sixth magnification, using a live blood preparation. Full doses of digitalis given to surra-positive camels some hours before injection are said to prevent fainting, but the writer has no experience in dealing with surra-positive camels by this method.

The nature of this phenomenon must be to some extent a matter of speculation, but it may perhaps be due to syncope induced by raising the blood pressure, when the volume of tartar emetic and salt solution is introduced into the jugular vein. Perhaps also the amount of toxin generated by trypanosomes in the peripheral circulation may bear some relation to the tonic state of the heart muscle during this period. Artificial respiration and peripheral stimulation have been found useful in dealing with camels that faint under intravenous injection. This should be begun immediately the animal loses consciousness and not discontinued till consciousness returns.

The advantage of beginning treatment in camels that present trypanosomes in their blood is emphasised in the "fly" season, when there is danger of spreading the disease to healthy camels and reinfecting those under treatment. However, there is no guarantee, in the present state of our knowledge, that the surra-infected presenting no trypanosomes in their blood, when examined microscopically, are not just as dangerous from this point of view.

Post-Mortem Appearances in the Treated Subject.

The pathological conditions found on post-mortem of the treated subject appear to bear definite relation to what is known of the general

action in the body of the salts of antimony, as in the same way they bear a distinct relation to those symptoms displayed during life of those animals that have fallen "sick" under treatment or have suffered from tartar emetic poisoning.

The outstanding features, taken from a series of post-mortems made on animals that have died whilst under treatment, are therefore given in explanation of the foregoing notes relating to dosage and the observation of the camel under treatment :—

The Carcase.—May or may not be emaciated, depending on the original condition of the animal at the commencement of treatment, or the length of time it has been suffering from antimony poisoning ;

FIG. 4.—Firing Marks on the Camel's Body and Chest, Indications of a Former Attack of Surra.

the visible mucous membrane stained a canary yellow colour, the abdominal tunic, the fascia of the body and limbs, stained yellow or even orange.

The Thorax.—The lungs are generally congested and inflated, and may present red and grey hepatisation ; occasionally gangrenous areas are found, but this does not appear to have any connection with the drug employed in treatment, as it is on occasion found in the lungs of surra camels that have died or been destroyed without treatment. The mediastinal glands do not appear to present any macroscopical pathological change.

The Heart.—Enlarged, pale in colour, flabby in consistence ; may be slightly yellow stained ; presents fatty degeneration ; the auricles and a portion of the ventricles may have a semi-transparent or gelatinous appearance ; fibrous thickening of the pericardium is not uncommon ; usually the pericardial sac contains 5 or 6 ounces of yellow or blood-tinged fluid.

The Abdomen.—Rumen and intestines normal in appearance. Spleen slightly enlarged, congested, and flabby to the touch.

The Liver.—Enlarged, pale, but tending towards a greenish colour,

bright orange on section. Presenting generalised fatty degeneration, it is easily macerated with the fingers.

The Kidneys.—Present fatty degeneration, renal, pelvic fat, orange in colour, enlarged, and flabby to the touch.

A quantity (10 to 15 ounces) of yellow stained serous fluid in the peritoneal cavity. Collections of yellowish semi-transparent gelatinous material may be found adhering to the diaphragm, free amongst the bowels, or in the pelvic cavity.

Brain and Meninges.—May be congested, meningeal fluid yellow in colour.

Post-Mortem Appearances in the Untreated Subject.

It is extraordinary how little pathological change is usually observed in a post-mortem made on a camel that has died or been destroyed for surra, where no treatment has been applied. In nine such post-mortems made the outstanding features were: General emaciation of the carcase, visible mucous membrane anæmic, body fascia and abdominal tunic white, instead of yellow or orange as in the case of those animals treated with potassium or sodium antimony tartrate; the heart is rather pale in colour, the pericardium contains invariably a few ounces of pale transparent exudate; the lungs are normal in appearance; 10 to 15 ounces of pale exudate is commonly found in the peritoneal cavity; the spleen, liver, and kidneys appear normal, and there is no visible change in the gastro-intestinal tract; large masses of semi-transparent gelatinous material are frequently found adhering to the diaphragm, free amongst the loops of intestine, or in the pelvic cavity; the tissues and organs generally have an anæmic appearance.

THE CARE OF THE CAMEL UNDER TREATMENT.

In order to obtain the best results in the treatment of surra it is necessary to put the camel under the best conditions, that is to say, feeding, watering, housing, clothing, browsing, and judicious exercise, should receive particular attention.

The best conditions, however, are not always available, but it may be said that the "management" of camels under treatment enters to a very great extent into the question of success or failure in so far as the Cross method of treatment is concerned. Foremost one may place the question of feeding. Suitable foods in good quantity are necessary. The camel is conservative in the matter of diet, and will generally, to begin with, refuse a new food. Once, however, he is induced to take it (this may often be brought about by hand feeding), he will eat it readily.

Contrary to expectation, he does not care for coarse, fibrous, stalky fodder, although the camel of the Punjab will pluck young green leaves and shoots from the most forbidding-looking thorn bushes and trees. For instance, if coarse green gram (gram that has been cut too late) be fed to him, he will eat the green tops and leave the coarse stalks towards the roots. He refuses maize stalks if coarse and fibrous, but eats them readily if young and tender.

He will not take any form of silage, and rejects fodder recently dressed with manure. The following is a list of suitable green fodders grown in the Punjab and eaten readily by the camel. These are useful as a diet or portion of a diet during treatment: Green taramira, green gram, young green wheat or oats (khasil), turnips, shaftal, burseem, young green maize, ambercane, lucerne, rowan, moth, mung, senje, and lana.

Missa bhoosa or bhoosa made from harvested gram stalks trodden out by oxen is a suitable food for camels in health, but given alone to camels under treatment would appear to increase the tendency to constipation ; however, it may be given as portion of a diet, but it should be screened before being fed as it is often dirty. White bhoosa made from the stalks of wheat and sometimes oats after harvesting, is not well digested, and is unsuitable as a food for sick camels, but for working camels in health it may be given at the rate of one part white bhoosa to two parts missa bhoosa.

In the Punjab the camel browses on shishem, kikar, pipal, nim, phulai, and many other trees, and grazes on certain young green grasses, refoils, and clovers. If the grazing and browsing grounds are not too far away, considerable benefit is derived from this form of diet, and the exercise obtained on the journey out and back is beneficial. It may be noted that camels browse well on moonlight nights.

Considerable improvement in results was obtained at Lahore after the system was instituted of sending out the camels under treatment to browsing lands about four miles distant. This was done during the intermissions of treatment, that is to say, after receiving an intravenous injection, camels were sent off to the grazing rakhs, and on their return on the third day were given their accumulated grain and fodder ration. They received an intravenous injection about midday, when they consumed the whole of their accumulated grain and about two-thirds of their green fodder, the balance of the fodder being consumed in the afternoon and evening before their return to the grazing grounds. So that all injections were given on a full stomach.

The daily allowance was at times supplemented by weeds collected

by the sarwans from gardens in the contonments, and the full seed pods from the kikar trees in the vicinity of the hospital. Gram is usually fed to camels as a grain ration, 4 to 8 lb. being the daily allowance, given dry or soaked in water. This quantity is generally fed at one time. Peas, sago, and the various dhals are also eaten readily.

Salt is a useful adjunct to any diet, specially for camels under treatment. Sometimes surra-infected camels suffer from indigestion, and are to be seen eating sand and earth ; salt appears to correct this. Rock salt, when given, is powdered and sprinkled over the grain ration. Camel men are in the habit of giving their camels quantities of salt the evening before an inspection takes place, so

FIG. 5.—Camels after a Course of Treatment with Sodium Antimony Tartrate. The three camels in the background came into Musth during treatment, but the good muscular development of their hind limbs is well demonstrated.

that on the following morning they are very thirsty and " blow " themselves out with water. This gives the animal a full, comfortable appearance, and improves more especially those that are in reality " tucked up." However, the muscle waste in such camels remains, and only the very unwary are deceived.

A general idea seems to prevail that the dromedary, normally an inhabitant of the desert, is not much affected by the sun's rays. This, however, does not seem to be the case with the Punjab camel, and it certainly is not the case with the camel suffering from surra. Further, the Punjab camel feels considerably cold and wet weather. Therefore in extremes of heat and cold it is advisable to house them whilst under treatment.

Most of the year round he is worried all day by flies and at night by mosquitoes, which give him no rest, but when housed and in sanitary surroundings these pests are lessened to some extent. It

has never been the writer's experience to find tabanus feeding on camels that are kept during the day in stables.

Jhools or camel rugs are useful in cold and wet weather, but are difficult to deal with where mange is prevalent, which unfortunately is often the case in the cold weather.

The treated camels at Lahore are given water twice a day in the cold weather, and offered water three times a day in the hot months of the year. They object to drinking on cold mornings.

The quantity of water daily consumed by a camel would appear to bear some relation to his diet. Camels fed daily on senje, a juicy fodder resembling clover, and those that browse on leaves wet with dew, drink very little.

The fæcal stasis that prevails during treatment is probably alleviated to some extent by judicious exercise, but there is danger of overtaxing the heart when long journeys to browsing grounds have to be made.

The surra-infected are particularly liable to chest pad injury during treatment, and many arrive for treatment with serious injuries of this nature. These are generally conspicuous in a line of camels, as they are usually seen to be standing when the remainder are " barrakked " (in the sitting position). These injuries are particularly hard to deal with, reminding one of " quittor " in the horse. As constant injury on hard and stony ground tends to aggravate this condition, it has been found beneficial to set apart an area 6 to 8 inches deep in sand or canal silt for the purpose of casting camels for intravenous injection and " barrakking " such camels for feeding, etc. The best method of dealing with these injuries appears to be that of laying open the sinuses, applying the actual cautery, and dressing daily with powdered potassium permanganate.

The Care of the Camel After Treatment.

There can be little doubt as to the efficiency of potassium antimony tartrate in dealing with surra in the camel, but it will be seen from the foregoing notes that it is a most drastic remedy, and may only be applied with safety under certain conditions, by experienced people, with care and foresight.

Captain Cross has kept camels that have been cured by his method of treatment for varying periods, and as long as 945 days, under constant observation.* Their blood has been continually examined microscopically during those periods, and it has remained negative to trypanosomes. Moreover, they have maintained perfect health. Further, laboratory animals have failed to become infected by their blood during those periods, which may be considered a severe test.

* Cross, Agricultural Research Institute, Pusa (Bulletin 95 of 1920).

In Silladar Camel Corps, where camels after discharge from hospital so often return to their villages where the original infection took place, occasionally cases become re-infected and are later returned for treatment. There would appear to be little or no protection gained after being cured from the first attack, except, as before noted, animals appear to have a greater toleration to the drug. Careful examination of the history and movements of such camels generally pointed to their becoming re-infected, and in those cases where there was doubt as to whether re-infection or relapse had occurred, reference to their treatment sheets generally pointed to long periods of " sickness " whilst undergoing treatment, and small doses being given after an intermission from treatment. In other words, at no period during treatment was the system ever thoroughly saturated with tartar emetic, which is imperative. Early experiments by Cross would appear to bear this out.

However, as in all diseases treated chemio-therapeutically, to definitely assert that a complete and undoubted cure has been wrought, time is required, and it is perhaps too early to state with confidence that potassium antimony tartrate may be considered as a specific. Therefore a means of branding treated camels has been devised which gives the year in which the camel was treated, and the drug employed, so that it may be noted at a glance. (See Fig. 4.) But it may be asserted that camels suffering from the disease rapidly regain health and condition after treatment, and have worked most satisfactorily under the severest conditions, whereas had they not been so dealt with they would have assuredly died. I instance thirty-nine camels of the 54th Camel Corps cured of surra by this means and sent to transport duty with the Razmak Field Force. These were in constant work under the severest climatic conditions, at times being buried to their necks in snow and marching with heavy loads over rough country. These animals returned in excellent condition, which speaks very highly for the treatment.

One has seen the very considerable pathological change that has taken place in those that have died or been destroyed during treatment. It is therefore not difficult to picture considerable pathological change having taken place in those that have completed the course of treatment. It is particularly noticeable that many camels do not put on condition rapidly, i.e. regain hump and develop muscle, till treatment has ceased. If camels are worked too hard and in the heat of the day, or too soon after treatment, and not cared for well in the matter of food, they do not regain condition, and cases of death have occurred from debility. Therefore a period of convalescence is required, during which time good browsing and only light work should be given.

(*To be continued.*)

Clinical Articles

URETHROTOMY IN A HORSE.

By DONALD CAMPBELL, M.R.C.V.S.,
Rutherglen.

In the *Veterinary Record* of December 20th last Professor Wooldridge recorded two very interesting cases, one in a gelding and the other in a male Irish terrier, in which he operated for stricture of the urethra by performing urethrotomy at the ischial arch, suturing the edges of the urethral wound to the skin, and so obtaining a permanent urinary opening at the site of his operation. His results seem to have been completely satisfactory.

In October of 1922 I performed a similar operation on a pony gelding, and though I cannot claim the unqualified success that Professor Wooldridge can—perhaps that was not to be expected—still my efforts saved, or at any rate prolonged, the pony's life, and also, since I think I can see now just where I went wrong, have proved of sound educational value to myself.

The pony had been at grass, and three days before I first saw him he got caught on an iron fence, which cut right through the prepuce about 3 inches behind its opening, leaving a transverse wound with the end of the penis hanging out of it. He micturated quite freely, but two days later the exposed portion of penis, 3 or 4 inches in length, fell off. It was then I was sent for. The wound was granulating surprisingly—it may be that the owner had not been quite frank about the date—and no trace of the truncated penis could be felt in the mass of tissue. The pony was in good health and appetite, micturating abundantly, and continued so for a fortnight. Then the passage of urine became difficult ; small quantities were voided at short intervals, after much straining and premonetary pain. Many times with catheter in hand I searched gently and perseveringly for the urethral opening, but never found it. Accordingly, the pony was chloroformed, and about 6 inches below the ischial arch I cut into the urethra, making a wound about 2 inches long, and sutured the edges of the urethral wound to the edges of the skin wound. As soon as I incised the urethra a great quantity of urine, mixed with mucus or pus, flowed out. In a few days' time some of my sutures came out, leaving the wound less wholesome to view. It gradually contracted till its diameter was about ½ inch, and at that it remained patent. Urine was passed in normal amount and at normal intervals, but to my thinking with less than the usual force ; and from

the position of the operation wound some of it always trickled down the thighs, scalding the skin to some extent. For four months afterwards the pony worked regularly and gave no trouble; then he was sold, his owner having bought a Ford van. What became of him afterwards I have never heard.

In its result my operation, it must be admitted, fell somewhat short of complete success. There were, I think, two reasons for that: the incision was not large enough, and it was made too low down. A larger incision would have done no harm, and it would have left room for mishaps in healing; while, if I had made it at the ischial arch instead of 6 inches below, there would have been less dragging on the sutures from movement of the limbs, and also less or no trickling of urine down the legs. Just why I made the incision where I did seems now rather difficult to explain, but with the patient lying on his back and his hind legs spread apart, the spot appeared less tucked away than it did later on when the pony was on his feet.

The operation is one I should have no hesitation in tackling again. Neither difficulty nor danger attends it, and any operator who avoids the mistakes I made should have every prospect of a completely successful outcome.

DROPSY OF THE UTERUS IN A MARE.

By FRANK HOPKIN, M.R.C.V.S.,
Manchester.

The patient was a thoroughbred mare, eleven years old, and expecting to foal in about nine weeks' time. I was called one night to attend her with what appeared to be an attack of colic. She was in a good deal of pain, and upon attempting rectal examination I could only get my arm in as far as the wrist. I gave a sedative which eased her to some extent, and a few hours later I decided to endeavour to bring about abortion by manipulation of the os uteri with my fingers. After working at it for some little time I managed to get it open and to burst the uterine membranes, upon which a large flow of fluid burst out. This measured over twenty stable bucketsful (approximately 40 gallons), and the latter portion of it was pumped out by the aid of a Reid's enema syringe. The mare seemed much relieved at the time, but died a week later from septicæmia. I was unable to reach the after-birth at the time, and was unable to get it away for twenty-four hours.

CASES OF ACUTE LEAD POISONING IN CATTLE.

By GERRARD WATKINS, M.R.C.V.S.,
Mareham-le-Fen.

Case 1.—I called to see five yearling heifers which had been in a field and had apparently been well the previous day. One was already dead, another very ill, and the other three apparently all right. The latter were taken ill on the following day. I found pieces of chewed leather covered with red paint near an old building in the field, and on making a post-mortem of the dead beast small portions of chewed leather were found in the rumen.

All the animals died within three days and all had pieces of leather covered with red paint in their respective rumens. This paint, in my opinion, was the cause of death.

Case 2.—I was called urgently one night to a yearling beast, which had been taken ill suddenly and died before I arrived. On the following day there was another ill at the same place. Being suspicious of poison I searched the field and found a broken gallon jar containing a quantity of dried lead paint. Upon making a post-mortem examination I found several large lumps of lead paint varying from the size of a Barcelona nut to a large walnut in the rumen.

This, in my opinion, was the cause of death.

Case 3.—A cow was seen to lick some liquid lead paint which a careless workman had left near a gate which he had been painting.

The animal was dead next morning, and the cause of death was certified on post-mortem examination to be lead poisoning.

REJUVENATION OF THE AGED FOWL THROUGH THYROID MEDICATION.*

By F. A. E. CREW.

In order to examine the hypothesis, so ably enunciated by the Steinach school, that senility is a phase of life that is attended by, perhaps even caused by, the inefficient functioning of one or more of the components of the endocrine system, the writer set out upon a series of attempts to evoke rejuvenation in the aged fowl. In a previous communication (Crew, 1925) an account was given of an unsuccessful attempt to produce this result in the aged cock by means of unilateral vasoligation. In this paper the results of thyroid administration to aged birds of both sexes are reviewed.

Thyroid has been given to the fowl for purposes of experimentation by several investigators. Torrey and Horning (1922) reported that when dried thyroid was given to growing males these assumed hen-

* Reprinted from the Proceedings of the Royal Society of Edinburgh.

feathering. Crew and Huxley (1923), repeating this work, but with different material and methods, failed to obtain confirmatory results. However, it was noticed during the course of this work that the administration of thyroid was followed by a marked increase in the rate of plumage growth and replacement, and that in the birds used, Rhode Island Red (red ground with black areas) and Light Sussex (white ground with black areas), the birds receiving thyroid exhibited a pronounced tendency towards increased melanism, the black areas being markedly increased in size and intensity at the expense of the other colours. Since it is known that such a parti-coloured bird tends to become lighter as it ages, the suggestion presented itself that in senility the thyroid of the fowl becomes relatively less efficient in its functioning. Moreover, the observation that thyroid administration increased the rate of feathering in the growing chick and moulting adult gained in significance when Serebrovsky (1922)—and more recently Warren (1925)—showed that quick feathering as contrasted with slow is a typical sex-linked character. One who seeks to interpret genetic action in terms physiological is attracted by the notion that this sex-linked factor in its action determines the time during development when first the thyroid comes into action or the degree of the functioning of this gland. Cole and Reid (1924) also have repeated the work of Torrey and Horning, and have obtained results which show beyond all doubt that thyroid administration does indeed affect the plumage characters of the male. They found that new feathers grown by the birds receiving desiccated thyroid showed distinct modification towards the female type of structure and colour, and that the rate of growth of these new feathers was noticeably increased. There was a reduction of red pigment, the distribution of which was irregular, and also a reduction of that area of the feather in which the barbs lack barbules, the feathers of the hackle regions, instead of being pointed and elongate, coming to possess broad rounded ends closely resembling the feathers of these regions in the female.

Willier (1924) successfully implanted small pieces of thyroid gland of the fowl on to the chorio-allantoic membrane of the developing chick at the seventh to tenth day of incubation. When examined at the seventeenth to eighteenth day of incubation the body of the developing chick was found to be emaciated and considerably smaller, the segments of the wings and the legs shortened, and the chick's own thyroid and gonads reduced in size. Willier does not record whether or not thyroid administered in this way increases the rate of plumage development, though in the photograph of his experimental and control chicks there seems to be evidence that it does. It is worthy

of note in this connection that those breeds in which the males are hen-feathered consist of comparatively small and active birds.

There are individuals and breeds which mature relatively early (five to six months) and others that mature late (ten to twelve months). The former are light, active, nervous birds, the latter are heavy, slow, and placid. The former as a class are aged when four, the latter do not show the unmistakable signs and symptoms of senility until about seven. In old age the head furnishings of both sexes are diminished in size, venous in colour, and flabby; the eye is dimmed; the plumage loose and ragged; the moult is irregular and the tail-sickles are commonly not replaced; the skin is less smooth, and the legs more scaly. The bird is either emaciated or excessively fat, and exhibits sexual behaviour but rarely, if at all. Both sexes become very inactive and spend the greater part of their time drowsing in solitude. They sleep on the floor rather than fly to the perch. The hens lay infrequently; the cock crows very occasionally, takes no interest in hens, and hastily shuns the presence of a younger male.

Five cocks and seven hens, all known to be old (five to eight years), and all showing the classical signs of old age but not those of gonadic disease, formed the experimental pen. Since this included so great a variety of breeds, and since to obtain really old birds is a matter of considerable difficulty, no control pen was maintained. To each of these birds desiccated thyroid (for the gift of which I wish to thank Messrs. Armour & Company) was administered daily for six months (May to October). The powder was incorporated in a small pellet of cold wet mash and given to each bird an hour or so before the morning feeding. During the first fortnight each bird received the equivalent of 0·2 mgm. of iodine each day, during the second fortnight 0·4 mgm., and thereafter 0·8 mgm. The results were striking.

From the table it may be seen that following upon the administration of thyroid the birds without exception promptly moulted and that the hens quickly started to produce eggs at a faster rate. These eggs were fertilised by the males in the pen. With the passing of the moult, the head furnishings became red and turgid, the plumage tight and close. All the birds became rejuvenated, looking fresh and being active. None of the hens became broody during the course of the experiment (twelve months), though six out of the seven belonged to the sitting breeds. This observation may possess some significance in view of what is known concerning the profound disturbances in the metabolism of the broody hen.

The plumage characters of the males were affected both in colour and structure: those of the hens in colour only. The black and white Houdan and Campine had become increasingly whiter with

	At Beginning of Experiment.				No. of Eggs during previous Six Months.	Period of Thyroid Administration.						Total No. of Eggs for Six Months.	Period following Thyroid Administration.						Total No. of Eggs for Six Months.	Remarks.
						No. of Eggs; M = Moult; Weight in Gms.							No. of Eggs; Weight in Gms.							
	Age.	Condition.	Weight in Gms.	Approximate Standard Weight in Gms.		May.	June.	July.	Aug.	Sept.	Oct.		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.		
♂ ♂ Houdan	7	Emaciated	3,150	3,800	—	M	—	—	3,370	—	3,500	—	—	—	2,450	—	—	3,300	—	Died following Nov. from roup.
Old English Game (blue)	8	,,	2,250	3,300	—	M	—	—	2,650	—	3,250	—	—	—	2,750	—	—	2,700	—	Still alive; very senile.
Scots Dumpie ..	7	,,	2,550	3,300	—	M	—	—	2,850	3,250	died	(roup)	—	—	—	—	—	—	—	—
Orloff	7	Fat	4,600	5,000	—	M	—	—	4,800 (died)	—	—	—	—	—	—	—	—	—	—	—
Campine	7	Cock-feathered	3,000	3,150	—	—	M (hen-fe	athere	d) —	3,100	—	3,100	—	—	—	3,100	—	—	3,100	—	Still alive; plumage interme diate.
♀ ♀ Silver Dorking ..	8	Fat	3,650	4,250	2	0 M	0	2	6 3,200 (died	— ruptur	— ed ovi	— duct)	—	—	—	—	—	—	—	—
Orloff	7	,,	3,650	4,000	4	0 M	1	0	5 3,600	7	4 3,580	17	died	(roup)	—	—	—	—	—	—
Croad Langshan ..	7	,,	2,850	3,100	6	2 M	4	9	6 2,950	8	7 3,280	36	6	7	5 3,250	0	1	0 2,950	19	Still alive; ovarian atrophy.
Scots Dumpie ..	7	,,	2,650	2,900	5	1	0 M	3	6 2,980	4	5 3,150	19	5	4	0 2,950	0	0	1 2,800	10	Died following Nov. (pneumonia).
Salmon Faverolle .	8	,,	2,280	2,400	4	0	2 M	4	6 2,470	4.	6 2,470	22	5	1 3,000	died	(ruptu	red ov	iduct)	6	—
Light Sussex ..	7	,,	2,075	3,000	13	3 M	5	8	7 2,580	10	7 2,580	41	9	6	2 2,400	1	2	4 2,500	24	Still alive; ovarian atrophy.
White Leghorn .	6	,,	1,700	2,000	8	1 M	12	10	18 1,950	10	18 1,950	69	15	15	10 1,920	12	6	2 1,850	60	Still alive; ovarian atrophy.

age. They moulted out as black as a two-year-old bird. The blue of the Old English Game had become lighter with succeeding moults. His smoky white plumage was replaced by a smooth blue. The gold black hackle of the Scots Dumpie was replaced by solid black. In the black and red Orloffs and in the silver Dorking hen the black was increased, whilst the barring of the Scots Dumpie hen became more distinct. No appreciable change was noticed in the colour of the Croad Langshan and Salmon Faverolle. The new neck hackle and tail of the Light Sussex hen carried far more black than those of a young bird of this breed. In the Houdan and the Orloff males the black was increased at the expense of the white or red in those feathers which are black on one side of the rachis, white or red on the other. The white and the red areas became peppered with black to form a condition similar to that ordinarily present in these feathers of the female.

The hackle feathers of all the cocks, previously elongate and pointed and with the barbs of the distal half free from barbules, were replaced by broad, blunt, gas-flame shaped feathers, with the barbule free area greatly reduced and very much like the hackle feathers of the female. None of the cocks could retain their new tail hackles. The Campine cock, hen-feathered in his earlier years, had become more and more cock-feathered with increasing age. He responded at once to the thyroid medication and became again hen-feathered.

The birds were kept under observation for six months after the cessation of thyroid administration. During the first half of this period they remained in excellent condition. After this they became progressively senile again. Two fell easy victims to roup and pneumonia. Rupture of the oviduct led to fatal peritonitis in two of the hens; but since this is a very common cause of death among domestic poultry, no special significance can be attached to its incidence in the experimental pen. The Orloff cock died of what must be diagnosed as old age: no organic lesion was present. All the hens that are still alive (April 1925) are exhibiting the classical signs of ovarian atrophy.

These results entirely confirm the conclusions of Torrey and Horning, Cole and Reid. Further, they show that rejuvenation in the fowl can be evoked by thyroid medication. They indicate that in old age in the fowl the thyroid is deficient in its functioning, and that the physiological activity of this gland is essential to the reproductive function. In old age the gonad of the fowl becomes inactive, reduced in size, and fibrotic. Apparently thyroid medication, supplementing the action of the bird's own thyroid, now inefficient, evokes a new lease of activity in the gonad, and the endocrine chain is thus repaired.

It would seem, then, that the physiological activity of the thyroid is concerned in the establishment of the type of feathering of the individual. If this is so, it is necessary to examine the commonly held opinion that the plumage characterisation is but the reflection of the kind of gonadic tissue present in the individual. It is true that in the presence of functional testicular tissue the plumage of the male or of the ovariotomised female is typically male ; that in the presence of ovarian tissue the plumage of the female and of the castrated male is typically female ; that in the presence of both testicular and ovarian tissues in the male or female it is female ; that the plumage of the capon and of the poularde is male-type in structure but more luxuriant and looser than that of the normal male ; and that in certain breeds the functional male is hen-feathered, and that this hen-feathering in the male behaves as a dominant Mendelian character in inheritance. These facts are usually interpreted on the assumption that the ovary of the hen and the testes of hen-feathered cocks elaborate an internal secretion that inhibits cock-feathering, and Morgan (1920) suggested that the source of this hormone was the luteal tissue. However, this suggestion has been shown by Pease (1921), Fell (1923), Nonidez (1922), and Greenwood (1925) to be unwarranted, and with the destruction of this hypothesis the evidence in favour of the production of specific sex hormones by the sex glands of the fowl becomes scanty indeed.

The facts can be accommodated in a simpler way than by evoking the aid of specific gonadic internal secretions, the existence of which cannot be demonstrated. The gonads undoubtedly play an important rôle in determining the character of the general metabolic processes of the body, and the metabolic level in male and female is demonstrably different. It is suggested that sex differences in plumage characters are but reflections of corresponding differences in the general metabolic processes of the body, and that these are due to the different metabolic needs of ovarian and testicular tissues. The ovary in its functioning exerts a very considerable physiological demand upon the general economy of the individual, and the demand of the testis is comparatively less. These differences are illustrated in sexual differences in blood fat and blood calcium content. The response to the demand of the gonad is regulated by components of the endocrine system ; by the thyroid among others. In the female the effect of the functioning of the ovary is such as to provoke in the thyroid an activity of such an order as to constitute the stimulus for hen-feathering. The thyroid of the cock-feathered cock is so stimulated by the physiological demands of the testes that its products are elaborated at a slower rate or in lesser quantity, and so the plumage

as it develops is as that of the typical male. Thyroid medication increases the quantity available for directing the growth of new feathers, and so the plumage of the cock becomes as that of the hen ; that of the hen is unaffected. The effects of gonadectomy and gonad implantation on the plumage are not direct effects but are secondary to a change in the rate or quality of thyroid functioning. Gonadectomy is followed by degenerative changes in the thyroid.

In the present state of our knowledge of the endocrinology of the fowl it is as reasonable to explain hen- and cock-feathering on the assumption that these are based upon sexual differences in thyroid functioning as to assume that the ovary of the hen elaborates an internal secretion of a kind qualitatively different to that produced by the testis of a cock, and that the testes of cock- and hen-feathered cocks are different endocrinologically.

It is necessary to attempt the interpretation of the fact that hen feathering in the cock behaves as a Mendelian character. Cunningham (1925) has recently hazarded the suggestion that this characterisation may be due to non-disjunction of the sex-chromosomes, but it will prove most difficult to secure any cytological support for this suggestion. It can be accepted that corresponding to any heritable character, physiological as well as morphological, there is a gene or gene-complex resident in the chromosomes. There is reason for holding that the rate or quality of the functioning of a gland of internal secretion is a character in the neo-Mendelian sense. It is suggested that a genetic difference in thyroid functioning is the basis of the difference between cock- and hen-feathered cocks ; that the thyroid of those breeds in which the cocks are hen-feathered is provoked to a fuller activity by a lesser stimulus than is that of the breeds in which the hen only is hen-feathered, and that this difference is genetic in nature.

There are two classes of fowls : (1) those with a thyroid which in the presence of active testis responds to a degree that provides that concentration of thyroid secretion in the blood which directs the activity of the feather follicles to the production of cock-feathering, and which in the presence of active ovary responds to a fuller degree and leads to hen-feathering ; and (2) those with a thyroid which responds fully to the lesser stimulus of active testis. The difference in the thyroid of the two classes is a genetic difference in the threshold of response on the part of the thyroid to a particular type of stimulus. It is suggested that there are genetic differences in the quality or degree of thyroid functioning, and that the feathered follicles are ambivalent, being capable of producing feathers of the cock- or the hen-type according to the kind or intensity of the stimulus that

directs their activity. These suggestions are reasonable, since thyroid from any source can supplement the bird's own, and a bird can be hen-, cock-, and hen-plumaged with successive moults. Further, the plumage characterisations can be controlled experimentally by gonadic grafts.

If the difference between cock- and hen-feathering lay in the physiological activity of the two types of testicular tissue, then interchange of testes should be followed by reversal of plumage type, the cock-feathered should become hen-feathered, and *vice versa*. Pézard, Sand, and Caridroit (1924) claim to have shown that the implantation of a testis from a hen-feathered cock into a cock-feathered cock was followed by the replacement of cock- by hen-feathering. This would seem at first sight to be a conclusive demonstration of the endocrinal differences in the testes of the two sorts of males. Further consideration of their claim, however, shows that it is by no means so. They used a heterozygous cock-feathered silver bird out of a Brown Leghorn × Dorking mating, " dont la masse testiculaire dépasse a peine le minimum efficace," implanting subcutaneously fragments of a testis derived from a hen-feathered Sebright. New feathers of the saddle region resembled those of a Brown Leghorn hen. There is much to criticise in this experiment, but for the moment it is enough to point out that in it the testes of a cock-feathered cock were not replaced by testicular material from a hen-feathered male, but that the host's own gonadic tissue was supplemented with testicular material from another source. If the host had been a developmental poularde—a hen in which the ovary had not functioned sufficiently at the time when the plumage was assumed—the testis implant might be expected to evoke a fuller activity of the bird's own gonad, and so hen-feathering would follow. If, on the other hand, as is more probable, the host was a developmental capon, the testis implant would create by its functioning an environment in which the bird's own testicular material would function more completely, and the unusual amount of testicular material present in this bird would be equivalent in its effect upon the thyroid to a functional ovary. Be this as it may, Pézard, Sand, and Caridroit failed to control their results by the implantation of testis from a cock-feathered male. Until it has been shown that the implantation of testis from a hen-feathered cock into a completely castrated cock-feathered male leads to hen-feathering, and that the augmentation of the testes of a cock-feathered cock by testicular material obtained from cock-feathered males does not, it cannot be maintained that the testes of the two sorts are endocrinologically different, or shown that the suggestion that the two races differ genetically in the threshold

of response on the part of the thyroid to gonadic stimulation is wrong. Experiments devised to answer these questions have been performed and the results will be communicated in a further paper.

The expenses incurred in the course of this investigation were met out of a grant made to me by the Government Grant Committee of the Royal Society, and for this I wish to express my gratitude.

Summary.

The administration of desiccated thyroid to aged fowls of both sexes is followed by definite rejuvenation effects. Cock-feathered cocks when so treated assume a plumage that is distinctly henny in structure and coloration.

It is suggested that the effect of gonad on plumage is not direct, but that it is secondary to the effect of gonad on thyroid. It is suggested further that the thyroid of those races in which the cocks are hen-feathered is genetically different from that of the cock-feathered in that it exhibits a lower threshold of response to the gonadic stimulus.

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Review

Diseases of the Cat. By CAPTAIN HAMILTON KIRK, M.R.C.V.S., author of *Canine Distemper*, and Lecturer on Animal Management to the London County Council. Pp. xiv + 418, with 62 illustrations. London: Baillière, Tindall and Cox. Price 10s. 6d.

Specialism has now so invaded even the veterinary side of medicine that one does not ever express surprise nowadays that a book on the diseases of so small an animal as the cat should run into over 400 pages.

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Notices

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THE Officers of the Comparative Section of the Royal Society of Medicine for 1925–26 are as follows:—

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Professor Hobday is also a Member of the Council of the Royal Society of Medicine and of the Section of Medicine.

Dr. T. W. M. Cameron, M.A., B.Sc., Ph.D., M.R.C.V.S., has been elected on the Council of the Tropical Diseases and Parasitology Section of the Royal Society of Medicine.

LECTURES AT THE LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE.

THE course is adapted for veterinary officials who hold positions in the Colonies and tropical countries. Several home on leave have already taken advantage of this privilege.

This course should be one which would be included as the foundation of a course for a Diploma in Tropical Veterinary Hygiene, similar in character and value to that awarded to the medical graduate who takes out a Post-Graduate Diploma in Tropical Medicine and Hygiene.

The complete course at present is three months, but it will shortly be increased to five months, and it is in connection with the University of London.

The Director is Dr. Andrew Balfour, C.B., C.M.G., M.D., and the Lecturers include Dr. R. T. Leiper, F.R.S., D.Sc., M.D., Ch.B., and Dr. T. W. M. Cameron, M.A., B.Sc., Ph.D., M.R.C.V.S.

THE ROYAL SANITARY INSTITUTE.

THE 36th Congress of the Institute was held at Edinburgh, from July 20th to 25th.

H.R.H. The Duke of York, K.G., K.T., G.C.V.O., accepted the Honorary Presidentship of the Congress, and the Right Hon. Sir John Gilmour, Bart., D.S.O., M.P., Secretary for Scotland, as President, delivered his inaugural address to the Congress.

Milk and Meat Inspection was one of the titles among the subjects of Public Health interest which were discussed, and visits were arranged to various Infirmaries, Tuberculosis Hospitals, Public Health Institutions, Markets, Slaughter Houses, and other places of Health and Historical Interest in and around Edinburgh.

The meeting of Veterinary Inspectors was held on Thursday, July 23rd, in the University, under the Presidency of Lieut.-Colonel Gerald Leighton, O.B.E., M.D., D.Sc., F.R.S.E., Medical Officer (Foods), Scottish Board of Health. The Recording Secretary was Mr. J. R. Hayhurst, M.R.C.V.S., D.V.S.M., Metropolitan Cattle Market, Islington, N.

WE draw the attention of our readers to an opportunity which will not last much longer for purchasing instruments and equipment at considerably under cost prices, as set forth in our advertisement pages by the enterprise of Messrs. Fleming and Co., 78 Upper Thames Street, E.C. 4, Government contractors, who have purchased the whole of the surplus veterinary stores left over from the late war.

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Personal

MR. FRED BULLOCK, Secretary and Registrar of the Royal College of Veterinary Surgeons, was successful at the recent examinations held by the Council of Legal Education, in securing the first place in the First Class in the Law of Real Property and Conveyancing.

Amongst the Vice-Presidents of the Medical Sociology Section at the recent British Medical Association Congress, held at Bath, we notice the name of MR. G. P. MALE, M.R.C.V.S., of Reading.

MR. W. J. IRONSIDE, M.R.C.V.S., has been appointed Lecturer on Veterinary Science at the Midland College of Agriculture and Dairy School at Sutton Bonington, Nottinghamshire. Mr. Ironside is also a qualified chemist as well as a veterinary graduate. He qualified in Edinburgh in 1923.

Amongst those who were presented to their Majesties the King and Queen at the Garden Party held in Buckingham Palace Grounds on July 22nd, we notice the names of MR. and MRS. J. EWING JOHNSTON of Belfast. Mr. J. Ewing Johnston, M.B.E., M.R.C.V.S., is the Honorary Veterinary Surgeon to His Excellency the Viceroy of Northern Ireland.

NOTICES

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